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The Webb Deep-Sky Society

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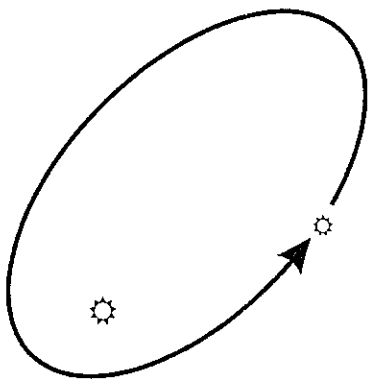
Double Star Section

Circular No. 20



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Double Star Section Circulars No 20

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LOST CHEVALIER PAIRS - A FOLLOWUP

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Introduction

Ernö Berkó (2011) recently undertook the commendable effort of investigating a large number of doubles which had been discoverered by Chevalier (1908) but never confirmed. While checking over Berkó's work in the course of entering his corrections into the WDS[1], some patterns began to emerge in these corrections; this prompted an analysis of Chevalier's paper. A number of errors were found in that early work, including one significant error which explained the reason for most of these 'lost' doubles. Other double star papers by Chevalier were then analyzed for similar errors.

Chevalier and the Shanghai Observatory

The Reverend Father Stanislaus Chevalier was born October 22, 1852, in Saint Laurent des Autels, Maine et Loire, France. He was sent to China in 1883 as a Jesuit missionary, and from 1888-1897 served as director of the Xu Jiahui (Zi-ka-wei) Magnetic and Meteorological Observatory, founded in 1872 by the French Mission Catholique near Shanghai. From 1897–1898 Chevalier surveyed the Upper Yang-tze river and published a major atlas of that region, for which he was awarded the Lorerot Gold Medal of the Paris Geographical Society (Rigge 1904).

In 1900 Chevalier and the Jesuits founded the Sheshan (Zo-Se) Astronomical Observatory, and installed a 40 cm double astrograph on top of Sheshan hill, located 40 km to the west of Shanghai (see Figure 1). This was the largest telescope in East Asia at that time[2]. Chevalier became director of Sheshan in 1901, and served in that capacity until 1924. During that time he was involved in a wide variety of astronomical endeavors in addition to his double star work, including observations of sunspots, comets, asteroids, the Moon, Jupiter (including its moons and occultations of stars by the planet), as well as stellar photometry. He photographed Halley's Comet in 1909, and attempted diameter measurements of both the Sun and Moon. His most ambitious effort, however, was a catalogue of positions for over 14,000 stars (discussed below).

The Chevalier Doubles

The pairs investigated here were published in a series of Zo-Se observatory reports between 1908 and 1911. The first two publications (Chevalier 1908, 1909) were comprised of measures of new pairs discovered on photographic plates, while the latter two (Chevalier 1910, 1911) also included visual micrometry measures of new and known pairs. For each photographic plate, Chevalier noted the coordinates (epoch 1900) of the plate center, as well as the plate scale and other plate constants, then gave a table of results. For each pair measured on that plate he noted the rectilinear offset (x,y) from the plate center to the primary in arcminutes, the resulting angular coordinates of the primary (RA, Dec), the offset (Δx,Δy) from the primary to the secondary, the resulting relative astrometry (θ,ρ), the diameter of each stellar image in microns, and a resulting estimate of magnitude for each component. In these four papers Chevalier made a total of 578 measures (49 visual, the remainder photographic) and discovered 471 doubles and 35 triples (although some of these "discoveries" were later determined to be known pairs).

[1] *Washington Double Star Catalog*, http://www.usno.navy.mil/USNO/astrometry/optical-IR-prod/wds/wds.html

[2] Although this was the same type of instrument used in the Carte du Ciel project, Sheshan was not one of the Carte du Ciel observing sites.

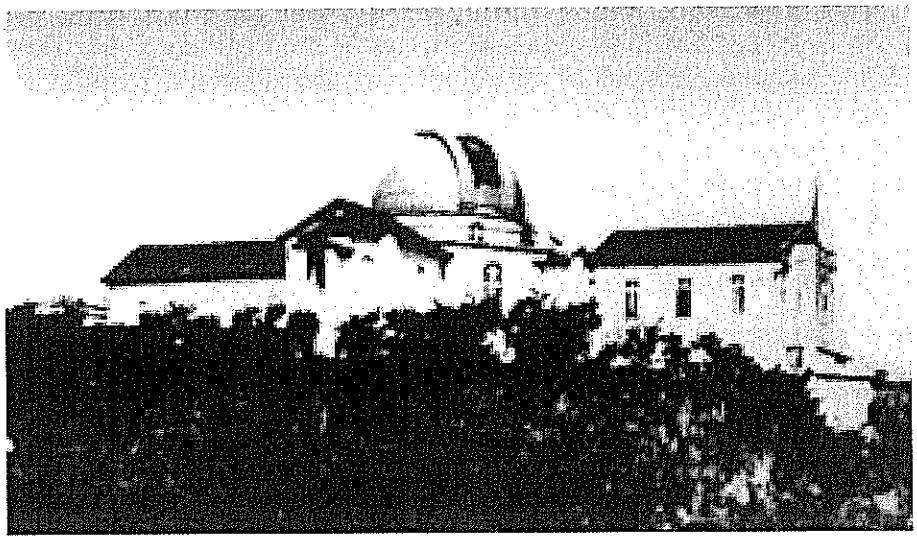

Figure 1: Old photograph of the Sheshan Observing Station (from Shanghai Observatory website: `http://www.shao.ac.cn/eng/au/hj/`).

In the current effort, any of Chevalier's systems for which there was uncertainty in coordinates, photometry, or relative astrometry was examined using Aladin (Bonnarel et al, 2000), then information was updated in the WDS database. Coordinate and proper motion information came primarily from UCAC3 (Zacharias et al. 2010); magnitudes came from GSC2.3 (Lasker et al. 2008) for most stars, Tycho (Hög et al. 2000) for the few stars brighter than 11^{th} magnitude, or NOMAD (Zacharias et al. 2004) for stars lacking Tycho and/or GSC data. All pairs whose coordinates and/or relative astrometry in Chevalier's paper were substantially corrected are listed in Table 1; columns in this table include WDS designation, Discoverer Designation (and components if part of a multiple system), V magnitudes for both components, corrected precise (epoch-2000) coordinates, Chevalier's observation date and corrected values for his position angle θ (in degrees) and relative separation ρ (in arcseconds), a reference to the original measure, and a flag indicating the error type. Note that Chevalier's measures are included only if they have been corrected in some manner.

As a part of this check, new matches against 2MASS (Cutrie et al. 2003) were made to the components of nearly all of Chevalier's pairs not previously matched; the additional measures resulting from these coordinate matches are also listed in Table 1 and have been added to the WDS database.

The following sections look at each of these four papers in a little more detail.

Chevalier (1908)

Chevalier measured pairs from four plates in his first double star paper. Three of the four plates (78 systems in total) had only a few errors of any consequence, as noted below.

Pairs from plate #3 (the subject of Berkó's investigation) were rather problematic, however. Chevalier measured 36 doubles and 1 triple, and nearly all of them have remained either unconfirmed or "confirmed" by an earlier automated match against 2MASS which instead found random faint pairs which agreed within search parameters.

In checking Berkó's matches, it was noticed that several pairs seemed to be offset by a similar amount from Chevalier's coordinates. Fortunately, Chevalier had provided notes identifying three primaries as Durchmusterung stars. A comparison of Chevalier's coordinates with values from SIMBAD found very consistent offsets of $-18^s.1$ in RA, $-1'05''$ in Dec for these objects, leading to the conclusion that Chevalier had apparently made an error in determining his plate center. When this offset was applied to Chevalier's coordinates for the other pairs, nearly all were immediately apparent on Aladin images.

However, another error was also discovered, one which caused Berkó to reject many of these pairs. In virtually all cases, the separation of the pair at the updated coordinates was correct, but the true

position angle was 180° minus the Chevalier value. The initial conclusion was that Chevalier had made a trigonometry error in reducing (Δx,Δy) to (θ,ρ), as seen for CHE 4 on another plate. However, the fact that nearly all such errors were confined to this one plate and nearly all pairs on that plate were affected led to a simpler conclusion: namely, that Chevalier had inadvertently flipped over the photographic plate before measuring his new pairs. It is impossible to know if this was indeed the case, but it seems the most likely cause; it may also account for the incorrect coordinates for the plate center.

Notes to some individual systems are given below.

Plate #1 (plate center 0017+26)

00199+2633	CHE 4	Chevalier's separation was correct, but his published (Δx,Δy) predict a different value than published. This was apparently due to a typographic error in Δy, which was printed as $-0\overset{s}{.}0317$ rather than $-0\overset{s}{.}0617$. There is also an apparent trigonometric error in his value for position angle. Chevalier gives a value for θ of 154°.62, but all later measures in the WDS give values of about 204°.0. It appears his value should be 360−154.62 = 205°.38 instead.
00210+2647	CHE 9	A similar typographical error as for CHE 4 above; Δx should be $+0\overset{s}{.}0708$. Also, Chevalier applied his declination offset from the plate center in the wrong direction, leading to an error of over 25′ in the coordinates. The image for the pair at the corrected coordinates is elongated on the Aladin plate; due to an uncertain relative proper motion it's impossible to tell whether his ρ and θ values are correct.
00234+2624	CHE 17	AC pair of triple: A similar typographical error as for CHE 4 above; Δy should be $-0\overset{s}{.}2783$.
00250+2726	CHE 24	There was a 1′ error in Chevalier's declination.

Plate #2 (plate center 0840+19)

08467+1914	CHE 507	Chevalier's separation is actually $11\overset{''}{.}58$ rather than $23\overset{''}{.}68$. This pair is identical with WDS 08462+1915 = STF1269, but the incorrect published value for ρ led to a match with a nearby pair which roughly agreed with the Chevalier measure. Measures in the WDS have been merged with those of the Struve pair.

Plate #3 (plate center 1947+22)

19493+2202	CHE 152	In addition to the plate center and trigonometry/plate errors, there was an additional 10′ error in Chevalier's declination, due to an error in applying the y offset. Berkó was unable to find a match.
19501+2325	CHE 155	After correcting for the plate center and trigonometry/plate errors, this pair was found to match 19498+2324 = J 496AB, as noted by Berkó. Measures have been merged in the WDS.
19501+2311	CHE 156	This pair was found to match 19498+2310 = POU4111. Measures have been merged in the WDS. Berkó's match is actually a new pair.
19511+2306	CHE 162	Berkó's match is actually CHE 164.
19511+2228	CHE 163	Berkó's match is actually a new pair. However, his pair 19508+2227 = Anon 13 is actually CHE 163.
19512+2306	CHE 164	Berkó's match is actually CHE 162. His pair Anon 18Ax is part of this system.
19513+2308	CHE 166	AC pair of triple: Berkó's match is actually CHE 165.
19513+2304	CHE 167	Berkó's match is actually a new pair. However, his pair 19500+2304 = Anon 9 is actually CHE 167.
19515+2240	CHE 168	Berkó's match is actually CHE 174.
19516+2320	CHE 169	This pair was found to match 19513+2319 = POU4120, as noted by Berkó. Measures have been merged in the WDS.
19518+2303	CHE 173	Berkó's match is actually CHE 175.
19527+2336	CHE 177	Berkó was unable to find a match to this pair.
19539+2317	CHE 181	Berkó's match is actually a new pair. However, his pair 19536+2316 = Anon 52 is actually CHE 181.
19541+2238	CHE 184	This pair was found to match 19538+2237 = COU 825AC. Measures have been merged in the WDS. Berkó's match is actually a new pair.

Plate #4 (plate center 2238+29)

22389+3010	CHE 331	Chevalier made an error in applying the RA offset.
22424+3025	CHE 380	There was possibly an error in either transcription or precession in generating the initial WDS designation, as the pair was at the location predicted from Chevalier's coordinates.
22458+3006	CHE 421	This pair was not found at the predicted location, nor was any likely pair seen at other locations resulting from transposing x and y offsets from the plate center, or possible sign errors in x and/or y. It remains the only one of Chevalier's doubles from this paper not recovered.

Chevalier (1909)

This paper had far fewer problems than the previous one, with minor issues found on only one of the seven plates measured. As noted in Table 1, five pairs were published with the position angle off by 180° (i.e., measured from secondary to primary rather than vice versa). These θ values have been corrected.

Plate #6 (plate center 2139+00)

21437+0030	CHE 315	There was an error in the printed declination, but the published offset from the plate center gives coordinates of a pair which matches that of Chevalier.

Chevalier (1910)

This paper included a short table of micrometry measures of new and known pairs, plus measures from six plates. Most of the problems involved the visual measures; the coordinates provided were often very poor (with errors as large as 30^s in RA and $3'$ in Dec), so it was not possible to recover all of Chevalier's discoveries.

Visual measures

05203+2510	STF 683	The identification of this pair was incorrectly labeled as STF 694, so the measure was never added to the WDS; the correct ID was determined based on his coordinates.
00240−0329	BU 488	Due to poor coordinates, this pair was originally added to the WDS as a new discovery: 00245−0327 CHE 23. The measure has been merged with the Burnham pair.
00094+1415	CHE 1	Due to poor coordinates, identification with the coordinates in Table 1 is uncertain. Chevalier's measure does not agree well with others for this pair.
00304−0947	CHE 27	This pair has opened considerably since its discovery (from $9''.6$ to $19''$), due to the considerable proper motion of the primary. AC2000 coordinates of both components from ~1901 are in good agreement with Chevalier's measure, however, so identification with this pair appears probable.
03109−0104	CHE 75	There is nothing that matches Chevalier's measure near the coordinates specified by him.
23505+0807	CHE 505	Chevalier gave an incorrect Durchmusterung number for this pair, leading to incorrect coordinates being added to the WDS.
23516+0841	CHE 506	Chevalier gave an incorrect Durchmusterung number for this pair, leading to incorrect coordinates being added to the WDS.
19594+2450	CHE 186	There is nothing that matches Chevalier's measure near the coordinates specified by him.
21014−0539	CHE 304	There is nothing that matches Chevalier's measure near the coordinates specified by him.

Plate #2 (plate center 0200+13)

02058+1241	CHE 42	There are no obvious errors in applying the offset from the plate center, but there are no appropriate pairs near Chevalier's coordinates, nor at coordinates found by reversing the sign of either or both offsets. The pair is likely lost.

Chevalier (1911)

This paper also included micrometry data as well as measures from four photographic plates. Poor coordinates for the visual discoveries were again a major source of error.

Visual measures

02020+0246	STF 202	Chevalier identified this star as α Psc, but gave an incorrect declination, leading to its initial designation as 02020+0320 CHE 32.
07075−0112	CHE 83	There is nothing that matches Chevalier's measure near the coordinates specified by him.
09285+0903	STF1356	Chevalier identified this star as ω Leo, but gave incorrect coordinates, leading to its initial designation as 09283+0903 CHE 137.

Plate #2 (plate center 2239+32)

22459+3252	CHE 425	Chevalier noted a large magnitude difference for this pair (5 mags). The bright primary has a large proper motion along approximately the same direction as the position angle. The elongated image seen in Aladin suggests that the pair has closed in separation and the secondary is currently lost in the primary's glare.
22467+3226	CHE 430	The double measured by Berkó (2010) is about 3′ from Chevalier's coordinates, but appears to be the correct pair.

Plate #3 (plate center 2321+42)

23246+4139	CHE 452	There are no obvious errors in applying the offset from the plate center, but there are no pairs at Chevalier's coordinates, nor at coordinates found by reversing the sign of either or both offsets.

Plate #4 (plate center 0846+12)

08506+1211	CHE 115	Based on a check of coordinates for other objects flagged as Durchmusterung stars, Chevalier's coordinates are very accurate for this plate. There are no obvious errors in applying the offset from the plate center, but there are no pairs at Chevalier's coordinates, nor at coordinates found by reversing the sign of either or both offsets. The pair is likely lost.
08546+1219	CHE 134	A star of appropriate magnitude is seen at Chevalier's coordinates, but with no companion. Reversing the sign of either or both offsets from the plate center yields no likely pairs, either. Perhaps the secondary measured by Chevalier was instead a plate flaw or other spot on the emulsion?

Chevalier's later years

Chevalier apparently did not publish any other double star data for some 14 years, probably due to the observatory's efforts in producing an astrometric catalog; this catalog eventually included positions for over 14,000 stars in the equatorial region (Chevalier 1928). However, at the end of his term as observatory director he did publish one small list of measures of known pairs, extracted from various photographic plates taken between 1912 and 1921 (Chevalier 1925). Figure 2 is a photograph of him from about this period.

Father Chevalier served again as director of Zi-ka-wei from 1926–1929, and died in Shanghai October 27, 1930. The Zi-ka-wei and Zo-Se Observatories merged in 1962 to form the current Shanghai Astronomical Observatory.

Figure 2: Group photograph at Sheshan (Zo-Se) Observatory, circa 1926 (frontispiece, Shanghai Obs. Zo-Se vol 15, 1927). Father Chevalier is seated in the center.

Table 1: New/corrected information for CHE doubles

WDS	Discoverer Designation	RA (2000) Dec	V_1 (mag)	V_2 (mag)	Date	θ (°)	ρ (″)	Ref	Note
00094+1415	CHE 1	000851.85+141505.7	11.0	13.2	1910.90	39.2	3.7	Che1910	1
00199+2633	CHE 4	001956.81+263340.8	12.8	14.1	1998.02	204.0	4.16	2MASS	
00204+2617	CHE 6	002018.13+261643.2	13.6	14.5	1998.02	186.5	11.93	2MASS	
00210+2647	CHE 9	002100.82+271305.5	10.1	13.2	1907.95	67.91	4.58	Che1908	1
00235+2709	CHE 18	002331.14+270936.9	11.5	13.4	1907.95	11.96	7.56	Che1908	2
00236+2621	CHE 19	002341.38+262056.6	11.7	13.6	1997.80	354.2	7.61	2MASS	
00237+2702	CHE 20	002351.97+270310.3	10.5	15.2	1997.80	209.2	17.27	2MASS	
00243+2634	CHE 22	002418.06+263506.9	13.1	15.0	1907.95	260.18	22.66	Che1908	2
					1997.80	261.3	22.62	2MASS	
00243+2731	CHE 21	002420.00+272805.0	14.0	14.3	1997.80	159.0	18.82	2MASS	
00250+2653	CHE 25	002458.76+265411.5	13.5	14.5	1998.88	80.7	23.75	2MASS	
00250+2726	CHE 24	002502.63+272742.4	13.9	14.6	1907.95	338.14	4.62	Che1908	1,3
					1998.88	339.0	4.88	2MASS	
00252+2743	CHE 26	002513.06+274353.6	11.9	12.2	1907.95	235.53	18.57	Che1908	2
00304−0947	CHE 27	003001.07−095213.9	11.9	13.0	1910.88	195.7	9.6	Che1910	1
02053+2836	CHE 40	020518.26+283602.9	12.3	13.4	1999.90	141.3	32.22	2MASS	
02060+2806	CHE 45	020601.47+280548.7	12.1	12.5	1999.90	42.2	41.14	2MASS	
02080+2814	CHE 55	020803.55+281323.7	12.4	14.0	1997.85	149.7	4.16	2MASS	
02085+2833	CHE 58	020831.86+283211.5	11.1	14.2	1997.85	291.2	13.68	2MASS	
02087+2921	CHE 60	020836.69+292018.6	12.9	14.5	1997.85	274.6	29.28	2MASS	
02109+2941	CHE 64	021052.92+294102.2	12.8	13.5	1997.85	124.7	16.84	2MASS	
04180+1433	CHE 78	041801.44+143321.8	12.0	12.4					
08137+0833	CHE 88	081340.33+083238.2	10.2	10.8					
08159+0932	CHE 98	081556.98+093201.6	12.2	13.0					

08467+1914	CHE 507	084640.61+191401.1	10.6	11.3	1906.86	307.12	11.58	Che1908	1,2
09261+0842	CHE 135	092609.65+084157.6	12.4	13.2					
09312+0845	CHE 140	093115.16+084425.7	12.4	11.8	2000.15	203.6	25.03	2MASS	
09585+2119	CHE 144	095826.50+211956.5	11.7	12.8	1998.07	265.5	27.22	2MASS	7
10002+2058	CHE 146	100012.86+205756.8	12.2	13.8	1998.07	35.2	29.81	2MASS	7
19485+2309	CHE 149	194812.52+230822.7	12.4	13.1	1907.69	261.10	15.64	Che1908	3,4,5
					2000.29	262.6	16.32	2MASS	
19490+2227	CHE 150	194839.98+222605.9	10.9	11.5	1907.69	88.50	24.89	Che1908	4,5
					2000.29	88.5	30.13	2MASS	
19491+2259	CHE 151	194847.36+225758.7	12.0	13.7	1907.69	282.15	21.47	Che1908	3,4,5
					2000.29	279.9	20.89	2MASS	
19493+2202	CHE 152	194904.82+221127.7	11.1	11.7	1907.69	253.56	26.78	Che1908	1,3,4
					2000.29	253.6	27.41	2MASS	
19495+2234	CHE 153	194910.66+223302.2	9.5	12.4	1907.69	111.26	22.96	Che1908	3,4,5
					2000.29	113.3	21.67	2MASS	
19495+2230	CHE 154	194915.09+222859.6	12.1	12.1	1907.69	114.78	19.55	Che1908	1,3,4
					2000.29	114.2	20.22	2MASS	
19501+2325	CHE 155	194945.39+232432.5	10.8	12.7	1907.69	264.79	5.14	Che1908	3,4,5
19501+2311	CHE 156	194947.85+231007.7	11.8	13.2	1907.69	251.93	11.92	Che1908	1,3,4
19508+2310	CHE 158	195027.93+230907.5	11.7	13.8	1907.69	146.44	8.80	Che1908	3,4,6
					2000.29	147.8	8.91	2MASS	
19508+2234	CHE 159	195031.00+223329.3	12.1	13.7	1907.69	224.69	22.06	Che1908	3,4,6
					2000.29	224.0	22.16	2MASS	
19509+2235	CHE 160	195034.48+223344.3	12.1	12.4	1907.69	150.98	28.55	Che1908	3,4,6
					2000.29	150.5	28.49	2MASS	
19511+2323	CHE 161	195047.62+232225.8	11.9	12.8	1907.69	111.24	12.11	Che1908	3,4,5
					2000.29	110.3	11.92	2MASS	
19511+2306	CHE 162	195048.77+230447.1	11.8	12.1	1907.69	75.31	22.93	Che1908	1,3,4
					2000.29	74.8	23.15	2MASS	
19511+2228	CHE 163	195049.13+222716.5	12.3	12.6	1907.69	154.19	7.99	Che1908	1,3,4
					2000.29	151.7	7.63	2MASS	
19512+2306	CHE 164	195055.44+230520.9	12.1	13.0	1907.69	107.00	24.85	Che1908	1,3,4
					2000.29	107.8	24.44	2MASS	
19513+2308	CHE 166AB	195057.10+230733.5	11.5	12.3	1907.69	256.54	11.63	Che1908	4,5
					2000.29	256.5	11.75	2MASS	
	CHE 166AC			12.7	1907.69	16.03	19.60	Che1908	1,3,4
					2000.29	15.1	19.42	2MASS	
19513+2309	CHE 165	195059.19+230808.4	12.3	13.8	1907.69	155.29	12.08	Che1908	3,4,6
					2000.29	155.2	12.05	2MASS	
19513+2304	CHE 167	195101.89+230332.1	11.8	13.7	1907.69	210.02	10.93	Che1908	1,3,4
					2000.32	208.7	10.12	2MASS	
19515+2240	CHE 168	195109.35+223933.1	12.6	13.6	1907.69	131.18	15.49	Che1908	1,3,4
					2000.32	136.5	14.90	2MASS	
19516+2320	CHE 169	195117.09+231848.2	11.4	13.7	1907.69	227.64	11.62	Che1908	1,3,4
19517+2257	CHE 170	195121.88+225644.4	11.6	13.3	1907.69	67.44	13.30	Che1908	4,5
					2000.32	62.7	14.61	2MASS	
19517+2223	CHE 171	195122.02+222202.7	12.5	13.1	1907.69	26.57	21.73	Che1908	3,4,6
					2000.32	24.2	21.16	2MASS	
19518+2344	CHE 172	195125.79+234255.8	11.6	12.6	1907.69	42.80	22.22	Che1908	3,4
					2000.32	45.3	22.63	2MASS	
19518+2303	CHE 173	195127.39+230219.4	12.2	12.8	1907.69	127.53	24.84	Che1908	1,3,4
					2000.32	127.7	24.97	2MASS	
19518+2240	CHE 174	195130.79+223903.0	11.8	12.9	1907.69	63.56	18.87	Che1908	3,4,6
					2000.32	58.8	21.69	2MASS	
19523+2249	CHE 176	195155.58+224803.3	10.9	12.6	1907.69	126.44	27.65	Che1908	3,4,6
					2000.32	125.9	27.60	2MASS	
19523+2307	CHE 175	195217.57+230713.9	11.7	12.9	1907.69	40.77	17.71	Che1908	3,4,6
					2000.32	43.6	16.79	2MASS	
19527+2336	CHE 177	195222.14+233514.3	11.2	12.3	1907.69	228.82	13.54	Che1908	1,3,4
					2000.32	226.0	11.76	2MASS	
19528+2246	CHE 178	195228.95+224432.4	13.3	14.1	1907.69	277.87	4.06	Che1908	3,4,5

					2000.32	281.4	3.92	2MASS	
19532+2223	CHE 179	195257.39+222117.2	12.4	12.9	1907.69	230.61	25.03	Che1908	3,4,6
					2000.32	230.6	34.76	2MASS	
19534+2246	CHE 180	195308.80+223404.4	12.3	13.5	1907.69	227.00	10.53	Che1908	3,4,6
					2000.32	232.4	9.74	2MASS	
19539+2317	CHE 181	195335.46+231535.7	10.7	13.0	1907.69	152.89	3.74	Che1908	1,3,4
19540+2309	CHE 183	195339.16+230711.3	11.9	13.8	1907.69	184.15	8.67	Che1908	3,4,5
					2000.32	188.0	6.86	2MASS	
19540+2333	CHE 182	195342.59+233119.1	10.7	12.0	1907.69	68.22	8.66	Che1908	3,4,6
					2000.32	71.4	8.25	2MASS	
19541+2238	CHE 184	195345.99+223634.0	9.6	14.3	1907.69	76.53	14.86	Che1908	1,3,4
19551+2317	CHE 185	195447.18+231548.1	12.3	12.5	1907.69	87.99	18.97	Che1908	2,4,5
					2000.30	93.8	19.55	2MASS	
20122+1512	CHE 188AB	201211.68+151159.1	12.4	12.4					
20122+1512	CHE 188AC	201211.68+151159.1	12.3	14.2	1998.73	75.4	33.62	2MASS	
20123+1607	CHE 189	201216.07+160629.8	12.8	12.6	1998.73	84.1	18.05	2MASS	
20123+1501	CHE 192	201222.25+150122.1	12.2	12.5	1998.73	5.5	25.00	2MASS	
20127+1508	CHE 196	201240.56+150742.3	11.1	12.4	1998.73	51.9	11.50	2MASS	
20128+1504	CHE 200	201250.30+150411.9	12.5	12.6	1998.73	147.1	16.39	2MASS	7
20129+1548	CHE 201AB	201251.31+154750.7	11.1	12.8	1998.73	321.8	27.87	2MASS	
20129+1548	CHE 201AE	201251.31+154750.7	11.1	12.0					
20130+1533	CHE 205	201259.94+153314.0	13.0	13.8	1998.73	338.2	23.45	2MASS	
20132+1503	CHE 208	201311.46+150244.4	12.8	13.5	1998.73	120.1	25.77	2MASS	
20134+1611	CHE 211	201325.93+161100.2	12.8	12.9	1998.73	339.6	21.69	2MASS	
20136+1537	CHE 215AB	201335.15+153642.7	11.8	12.6	1998.73	95.2	32.62	2MASS	
20139+1529	CHE 220	201355.47+152857.1	13.3	13.6					7
20143+1451	CHE 226	201420.17+145140.5	12.9	13.7	1998.73	285.3	12.89	2MASS	
20144+1608	CHE 228AB	201424.25+160818.9	11.2	13.4	1998.73	309.4	38.64	2MASS	
20144+1608	CHE 228AC	201424.25+160818.9	11.2	14.0					
20144+1533	CHE 229	201425.04+153251.8	11.7	13.1	1998.73	261.0	17.72	2MASS	
20146+1452	CHE 235	201436.19+145235.1	12.3	13.6	1998.73	28.5	13.92	2MASS	
20148+1616	CHE 237	201449.53+161630.4	12.8	13.9	1998.73	218.9	21.97	2MASS	
20151+1555	CHE 241	201506.45+155538.0	12.6	13.5	1998.73	48.9	21.39	2MASS	
20154+1538	CHE 243AB	201523.34+153815.3	10.9	13.6	1998.73	221.6	24.00	2MASS	
20154+1538	CHE 243AC	201523.34+153815.3	10.9	13.5					
20161+1537	CHE 255	201604.87+153712.4	13.5	13.5	1998.73	217.0	23.61	2MASS	
20161+1553	CHE 254AB	201608.72+155248.5	13.7	14.5	1998.73	133.7	26.67	2MASS	
20163+1615	CHE 260	201614.61+161549.7	13.3	14.0	1998.73	200.4	27.05	2MASS	
20163+1538	CHE 261AB	201616.59+153814.8	12.5	12.6	1998.73	41.0	18.47	2MASS	
20163+1538	CHE 261AC	201616.59+153814.8	12.5	13.6	1998.73	110.1	23.75	2MASS	
20166+1606	CHE 263	201634.36+160607.6	11.4	13.0					
20171+1536	CHE 272	201704.03+153504.4	12.7	13.3	1998.73	105.4	17.76	2MASS	
20173+1443	CHE 275	201720.85+144206.2	11.7	12.9	2000.51	330.2	31.51	2MASS	
20177+1503	CHE 279	201742.98+150225.0	12.7	14.2	2000.51	181.1	6.76	2MASS	
20178+1440	CHE 282	201748.59+144002.2	11.0	13.1	1999.62	133.8	14.98	2MASS	
20180+1501	CHE 287	201800.58+150033.6	13.2	14.3	1998.74	135.5	27.19	2MASS	
20183+1539	CHE 293	201820.05+153843.2	11.6	12.5	1998.74	353.9	24.88	2MASS	7
20186+1548	CHE 295	201836.96+154745.5	13.0	13.3	1998.74	261.0	13.74	2MASS	
20186+1444	CHE 296	201838.20+144520.8	12.8	13.1	1998.74	23.6	29.46	2MASS	
20187+1551	CHE 297AB	201844.52+155010.4	11.3	11.5	1998.74	0.5	35.93	2MASS	
20187+1551	CHE 298AC	201844.52+155010.4	11.3	12.3	1998.74	317.3	16.87	2MASS	
20187+1551	CHE 298BC	201844.56+155046.3	11.5	12.3	1998.74	206.6	26.31	2MASS	
20188+1530	CHE 299AC	201849.47+152955.3	12.5	13.4	1998.74	328.9	37.23	2MASS	
20189+1546	CHE 301	201854.48+154542.1	11.9	12.7	1998.74	295.7	27.67	2MASS	
21421+0104	CHE 309	214204.51+010437.6	10.1	13.3	1907.74	346.87	27.45	Che1909	7
					2000.59	337.6	27.49	2MASS	
21421+0059	CHE 310	214210.82+005915.0	13.8	13.8					
21428+0028	CHE 313	214250.67+002812.5	12.3	13.5	1907.74	137.24	9.67	Che1909	7
					2000.59	173.5	7.13	2MASS	
21435+0003	CHE 314	214328.82+000305.0	9.2	13.8	1907.74	226.23	40.53	Che1909	7
					1998.70	228.3	38.27	2MASS	

21437+0030	CHE 315	214344.26+003621.4	12.0	14.2	1907.74	330.82	10.37	Che1909	7
					2000.63	333.3	9.67	2MASS	
21447−0003	CHE 317	214444.43−000422.8	11.4	14.0	1907.74	223.54	28.64	Che1909	7
					1998.70	223.2	29.15	2MASS	
21453+0007	CHE 318	214521.19+000644.3	11.0	12.5	1907.74	120.33	26.27	Che1909	7
					1999.67	120.8	26.34	2MASS	
21457+0031	CHE 319	214545.35+003050.8	13.3	13.6	1907.74	100.22	30.07	Che1909	7
					2000.59	100.6	29.46	2MASS	
21459+0015	CHE 320	214558.72+001443.1	13.0	13.0	2000.59	272.8	13.17	2MASS	
21467+0007	CHE 323	214644.69+000604.5	13.1	13.6	2000.59	315.7	28.54	2MASS	
21467+0110	CHE 322	214644.92+011010.1	11.3	12.8	2000.59	129.7	9.56	2MASS	7
22389+3010	CHE 331	223922.87+300948.8	13.8	14.0	1906.86	13.17	12.45	Che1908	1
					1998.43	14.9	12.50	2MASS	
22396+3040	CHE 332	223931.78+304037.4	12.9	13.0	1998.43	262.9	27.84	2MASS	
22401+3258	CHE 336AB	223948.42+325903.6	12.1	12.3	1998.43	61.0	14.52	2MASS	
22405+2939	CHE 343	224027.76+293911.6	10.9	14.5	1997.87	42.3	6.45	2MASS	
22406+2933	CHE 345	224038.02+293323.9	12.3	12.4	1997.87	326.4	21.97	2MASS	
22407+2959	STF3134	224043.16+295932.5	9.6	10.1	1906.86	76.62	6.33	Che1908	2
22412+3223	CHE 355	224116.54+322319.4	14.0	14.3	1998.47	24.4	32.67	2MASS	
22413+2925	CHE 359	224117.34+292515.2	12.7	14.1	1997.87	259.4	14.16	2MASS	
22417+3059	CHE 368	224141.88+305850.9	11.1	12.1	1906.86	323.06	8.47	Che1908	3
22418+3041	CHE 370AB	224149.05+304017.2	12.8	13.1	1998.47	205.6	10.80	2MASS	
	CHE 370AC	224149.05+304017.2	12.8	14.0	1906.86	150.19	27.76	Che1908	2
					1998.47	156.0	28.74	2MASS	
22424+3025	CHE 380	224221.32+295512.7	12.5	13.0	1906.86	218.76	25.62	Che1908	1
					1998.47	218.9	27.51	2MASS	
22426+3232	CHE 383	224236.93+323243.8	10.7	12.8	1998.47	183.2	33.07	2MASS	
22430+2944	CHE 393	224239.26+294420.8	13.3	13.6	1906.86	113.47	13.82	Che1908	
					1998.75	122.9	13.76	2MASS	
22427+3254	CHE 385AC	224243.03+325335.4	9.4	11.8	1998.47	221.4	12.95	2MASS	
22430+3004	CHE 392	224258.15+300442.4	12.1	14.2	1998.47	246.0	27.00	2MASS	
22432+2941	CHE 395	224314.48+294150.1	13.6	14.0	1998.75	283.8	18.23	2MASS	
22443+2957	CHE 407	224407.90+295532.6	12.8	13.0	1906.86	216.65	24.04	Che1908	
					1998.47	218.3	24.54	2MASS	
22456+3027	CHE 418	224534.46+302633.2	6.5	13.3	1998.76	25.9	45.19	2MASS	
22458+3006	CHE 421				1906.86	338.39	19.26	Che1908	1
22458+2940	CHE 423	224550.30+293853.5	12.7	13.8	1906.86	248.00	5.89	Che1908	2
22459+3252	CHE 425	224554.08+325132.1	8.8	14.					1
22463+3319	CHE 428AB	224618.78+331914.0	10.4	13.4	1998.76	160.9	31.33	2MASS	
22467+3226	CHE 430	224656.79+322512.9	14.2	15.0	1910.83	285.16	14.76	Che1911	1
23226+4150	CHE 440	232234.76+415000.6	11.2	14.3	1999.85	125.4	27.27	2MASS	
23227+4142	CHE 443	232242.14+414140.5	11.2	12.0	1999.85	23.8	4.98	2MASS	7
23234+4248	CHE 445	232321.59+424733.9	10.5	13.5	2000.76	253.7	31.42	2MASS	
23245+4223	CHE 450AB	232430.85+422251.0	13.5	13.9	1998.80	334.2	12.09	2MASS	
23245+4223	CHE 450AC	232430.85+422251.0	13.5	14.0					
23260+4201	CHE 458AB	232600.06+420049.5	13.5	14.2	1998.80	262.0	30.06	2MASS	
23271+4201	CHE 468	232703.83+420052.4	8.5	14.4	1998.80	84.5	16.51	2MASS	
23278+4218	CHE 477	232752.22+421829.9	13.4	13.9	1998.80	230.2	39.42	2MASS	
23280+4301	CHE 481	232802.84+430040.8	10.4	13.1	1998.80	281.9	15.18	2MASS	
23288+4144	CHE 492AB	232848.85+414430.1	10.5	12.7	1999.76	66.2	18.86	2MASS	
23293+4152	CHE 497	232919.38+415217.7	12.5	13.7	1999.76	50.1	7.01	2MASS	
23338+1159	CHE 504	233348.63+115859.4	10.5	10.7					
23505+0807	CHE 505	234939.55+083736.0	10.5	11.9	2000.74	215.9	16.94	2MASS	1
23516+0841	CHE 506	235136.67+083741.9	11.4	12.3	1910.95	82.6	8.9	Che1910	1
					2000.72	79.5	8.97	2MASS	

1. See comments in text.
2. Reduction error in converting from (Δx,Δy) to (ρ, θ).
3. Error in deriving θ; correct value is 180°$-\theta$ (or 360°$-\theta$ if the secondary was found to be the brighter

component).
4. Error in original coordinates due to incorrect coordinates of plate center.
5. Berko's (2011) match to this pair is correct.
6. Berko's (2011) match to this pair is actually a new pair.
7. Chevalier's θ was flipped by 180° to make the primary the brighter component.

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